

Claims:

What is claimed is:

1. A polarization recovery apparatus comprising:

a polarizing beam splitter transmitting a light of a useful polarization in an output direction and reflecting a light of a non-useful polarization in a first orthogonal direction substantially orthogonal to said output direction;

an initial reflector disposed reflectably to said first orthogonal direction, said initial reflector reflecting said non-useful polarization light in a second orthogonal direction substantially orthogonal to said output direction and said first orthogonal direction; and

a final reflector disposed reflectably to said second orthogonal direction, said final reflector reflecting said non-useful polarization light in said output direction;

wherein said non-useful polarization light is rotated substantially to light of said useful polarization by said initial and final reflectors.

2. The polarization recovery apparatus of claim 1, comprising further:

a first output reflector disposed reflectably to said output direction, said first output reflector reflecting said useful polarization light in said second orthogonal direction; and

a second output reflector disposed reflectably to said second orthogonal direction, said second output reflector reflecting said useful polarization light in said output direction.

3. The polarization recovery apparatus of claim 2, wherein said first output reflector is selected from the group consisting of:

a prism,

a right angle prism,

a mismatched impedance, and

a mirror.

4. The polarization recovery apparatus of claim 2, wherein said first output reflector has a coating that transmits a pre-determined portion of the electromagnetic radiation spectrum selected from the group consisting of:

infrared light,

- visible light,
- a pre-determined band of wavelengths of light,
- a specific color of light, and
- a combination thereof.

5. The polarization recovery apparatus of claim 2, wherein said second output reflector is selected from the group consisting of:

- a prism,
- a right angle prism,
- a mismatched impedance, and
- a mirror.

6. The polarization recovery apparatus of claim 2, wherein said second output reflector has a coating that transmits a pre-determined portion of the electromagnetic radiation spectrum selected from the group consisting of:

- infrared light,
- visible light,
- a pre-determined band of wavelengths of light,
- a specific color of light, and
- a combination thereof.

7. The polarization recovery apparatus of claim 1, comprising further:

an input light pipe having an input surface and an output surface, said output surface disposed proximate to an input face of said polarizing beam splitter, said input light pipe receiving substantially un-polarized light at said input surface and transmitting said un-polarized light at said output surface to said polarizing beam splitter.

8. The polarization recovery apparatus of claim 7, wherein a shape of said input surface is selected from the group consisting of:

- flat,
- convex,
- concave,
- toroidal, and
- spherical.

9. The polarization recovery apparatus of claim 7, wherein a shape of said output surface is selected from the group consisting of:

flat,  
convex,  
concave,  
toroidal, and  
spherical.

10. The polarization recovery apparatus of claim 7, wherein said input light pipe is comprised of a material selected from the group consisting of quartz, glass, plastic, or acrylic.

11. The polarization recovery apparatus of claim 7, wherein said input light pipe is selected from the group consisting of:

a SLP, and  
a TLP.

12. The polarization recovery apparatus of claim 1, comprising further:

an output light pipe having an input surface disposed proximate to said output direction and an output surface, said output light pipe receiving said useful polarization light at said input surface and transmitting said useful polarization light at said output surface.

13. The polarization recovery apparatus of claim 12, wherein a shape of said input surface is selected from the group consisting of:

flat,  
convex,  
concave,  
toroidal, and  
spherical.

14. The polarization recovery apparatus of claim 12, wherein a shape of said output surface is selected from the group consisting of:

flat,  
convex,

concave,  
toroidal, and  
spherical.

15. The polarization recovery apparatus of claim 12, wherein said output light pipe is comprised of a material selected from the group consisting of quartz, glass, plastic, or acrylic.

16. The polarization recovery apparatus of claim 12, wherein said output light pipe is selected from the group consisting of:

a SLP, and  
a TLP.

17. The polarization recovery apparatus of claim 1, wherein said initial reflector is selected from the group consisting of:

a prism,  
a right angle prism,  
a mismatched impedance, and  
a mirror.

18. The polarization recovery apparatus of claim 1, wherein said initial reflector has a coating that transmits a pre-determined portion of the electromagnetic radiation spectrum selected from the group consisting of:

infrared light,  
visible light,  
a pre-determined band of wavelengths of light,  
a specific color of light, and  
a combination thereof.

19. The polarization recovery apparatus of claim 1, wherein said final reflector is selected from the group consisting of:

a prism,  
a right angle prism,  
a mismatched impedance, and  
a mirror.

20. The polarization recovery apparatus of claim 1, wherein said final reflector has a coating that transmits a pre-determined portion of the electro-magnetic radiation spectrum selected from the group consisting of:

- infrared light,
- visible light,
- a pre-determined band of wavelengths of light,
- a specific color of light, and
- a combination thereof.

21. The polarization recovery apparatus of claim 1, comprising further:

- a shell reflector having a first and a second focal points;

- a source of electro-magnetic radiation disposed proximate to said first focal point of said shell reflector to emit rays of light that reflect from said shell reflector and converge substantially at said second focal point;

- wherein said input surface is disposed proximate to said second focal point to collect and transmit substantially all of said light.

22. The polarization recovery apparatus of claim 21, wherein said shell reflector comprises at least a portion of a shape selected from the group consisting of:

- a substantially elliptical surface of revolution,
- a substantially spherical surface of revolution, and
- a substantially toric surface of revolution.

23. The polarization recovery apparatus of claim 21, wherein said shell reflector comprises a primary reflector having a first optical axis, and said first focal point is a focal point of said primary reflector, said shell reflector comprising further:

- a secondary reflector having a second optical axis placed substantially symmetrically to said primary reflector such that said first and second optical axes are substantially collinear, and wherein said second focal point is a focal point of said secondary reflector; and

- wherein said rays of light reflect from said primary reflector toward said secondary reflector and converge substantially at said second focal point.

24. The polarization recovery apparatus of claim 23, wherein said primary and secondary reflectors each comprise at least a portion of a shape selected from the group consisting of:

a substantially elliptical surface of revolution, and.

a substantially parabolic surface of revolution.

25. The polarization recovery apparatus of claim 23, wherein:

said primary reflector comprises at least a portion of a substantially elliptical surface of revolution; and

said secondary reflector comprises at least a portion of a substantially hyperbolic surface of revolution.

26. The polarization recovery apparatus of claim 23, wherein:

said primary reflector comprises at least a portion of a substantially hyperbolic surface of revolution; and

said secondary reflector comprises at least a portion of a substantially elliptical surface of revolution.

27. The polarization recovery apparatus of claim 23, wherein said shell reflector has a coating that transmits a pre-determined portion of the electromagnetic radiation spectrum selected from the group consisting of:

infrared light,

visible light,

a pre-determined band of wavelengths of light,

a specific color of light, and

a combination thereof.

28. The polarization recovery apparatus of claim 21, further comprising a retro-reflector disposed on a side of said source opposite said shell reflector.

29. The polarization recovery apparatus of claim 28, wherein said retro-reflector comprises a spherical retro-reflector.

30. The polarization recovery apparatus of claim 28, wherein said retro-reflector has a coating that transmits a pre-determined portion of the electromagnetic radiation spectrum selected from the group consisting of:

infrared light,

visible light,  
a pre-determined band of wavelengths of light,  
a specific color of light, and  
a combination thereof.

31. The polarization recovery apparatus of claim 21, wherein said source of electro-magnetic radiation comprises an arc lamp.

32. The polarization recovery apparatus of claim 31, wherein said arc lamp comprises a lamp selected from the group consisting of a xenon lamp, a metal halide lamp, a UHP lamp, a HID lamp, or a mercury lamp.

33. The polarization recovery apparatus of claim 21, wherein said source of electro-magnetic radiation is selected from the group consisting of a halogen lamp, and a filament lamp.

34. The polarization recovery apparatus of claim 1, comprising further:  
an image projection apparatus disposed proximate to said output direction to collect substantially said useful polarization light.

35. The polarization recovery apparatus of claim 34, wherein said image projection apparatus is selected from the group consisting of:

an LCOS imager,  
a DMD chip, and  
a transmissive LCD panel.

36. The polarization recovery apparatus of claim 21, wherein a shape of said polarizing beam splitter is matched substantially to an aperture of said source of electro-magnetic radiation.

37. The polarization recovery apparatus of claim 1, wherein said polarizing beam splitter comprises a wire-grid polarizing beam splitter.

38. A method of polarization recovery comprising:  
polarizing substantially light into light of a useful polarization and light of a non-useful polarization;

transmitting said useful polarization light in an output direction;

reflecting said non-useful polarization light in a first orthogonal direction substantially orthogonal to said output direction;

reflecting said non-useful polarization light in a second orthogonal direction substantially orthogonal to said output direction and said first orthogonal direction;

and

reflecting said non-useful polarization light in said output direction.

39. A system of polarization recovery comprising:

means for polarizing substantially light into light of a useful polarization and light of a non-useful polarization;

means for transmitting said useful light in an output direction;

means for reflecting said non-useful light in a first orthogonal direction substantially orthogonal to said output direction;

means for reflecting said non-useful light in a second orthogonal direction substantially orthogonal to said output direction and said first orthogonal direction;

and

means for reflecting said non-useful light in said output direction.